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PROPOSAL:

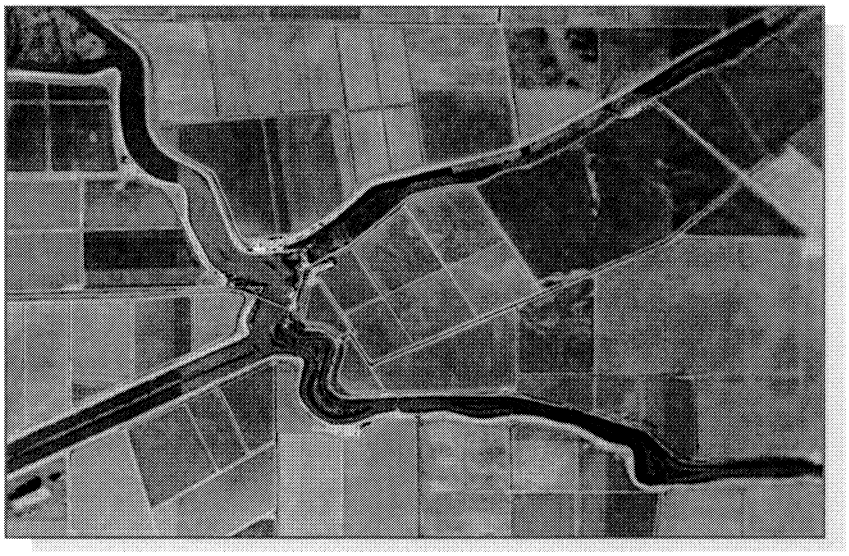
CHARACTERIZATION OF THREATS TO WATER RESOURCES FROM DREDGE SEDIMENTS USED ON LEVEES

in the

SACRAMENTO – SAN JOAQUIN DELTA ISLANDS, CALIFORNIA

RESPONSE to January 4, 2006 RFP by:

CALFED LEVEE SYSTEM INTEGRITY PROGRAM
UNITED STATES ARMY CORPS OF ENGINEERS
CALIFORNIA DEPARTMENT OF WATER RESOURCES



February 3, 2006

Environmental Risk Services Corporation

ERS

PROPOSAL: CHARACTERIZATION OF THREATS TO WATER RESOURCES FROM DREDGE SEDIMENTS USED ON LEVEES

in the

SACRAMENTO – SAN JOAQUIN DELTA ISLANDS, CALIFORNIA

February 3, 2006

Responds to:

January 4, 2006 Request for Proposal
CALFED Levee System Integrity Program

Submitted to:

United States Army Corps of Engineers
California Department of Water Resources

Prepared by:

Environmental Risk Services Corporation
2121 N. California Blvd., Walnut Creek, California 94596

Mark J. O'Brien
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SECTION PAGE

1. INTRODUCTION AND EXECUTIVE SUMMARY

Environmental Risk Services Corporation (ERS) has prepared this *Proposal: Characterization of Threats to Water Resources from Dredge Sediments Used on Levees in the Sacramento – San Joaquin Delta Islands, California* (Proposal) pursuant to the CALFED request for proposal (RFP) dated January 4, 2006. This proposed study is focused on characterizing the potential impacts, both beneficial and detrimental, to water resources posed by dredge sediments used on levees throughout the Delta. This proposal follows the structure prescribed in the RFP.

Dredged sediments have been used to construct levees and reclaim land throughout the Delta since the 1870s. Dredge sediments are the least expensive and most readily available source of levee construction materials. In addition, the dredging of the waterways in the Delta and management of the sediments are vital to maintaining many other needs, including navigation, flood control, flood capacity, hydraulic pressures on levees, habitats, and water quality.

However, the California Regional Water Quality Control Board – Central Valley Region (Regional Board) does not currently allow dredge sediments to be used on levees. Additionally, the Regional Board is nearly to the point of classifying dredge sediments as a designated waste. Such a classification would require dredge sediments to be placed in an engineered permitted landfill and would prohibit reuse of dredge sediments on levees.

These prohibitions are based on the Regional Board's concern that dredge sediments pose a significant threat to the quality of water resources in the Delta. However, there is currently little basis for the Regional Board to conclude that dredge sediments do or do not pose a threat. Erring on the side of caution, the Regional Board will be most protective of the water resources.

The economic and environmental impacts of these Regional Board prohibitions are very significant. Currently, fill materials used to construct, repair, and maintain levees must be imported into the Delta. The monetary cost to import fill materials can be 5 times to 10 times more than using the readily and locally available dredge sediments. Environmental impacts associated with the prohibition include increased diesel emissions from the trucks importing fill materials from outside the Delta. Infrastructure impacts associated with the prohibition include increased wear and tear on the fragile Delta roads.

Therefore, generating information about the actual impacts from dredge sediments is expected to allow the Regional Board to relax the prohibitions. Given the current public awareness of the need to repair levees, the permitted use of dredge sediments on levees will increase the cost-effectiveness of levee repair, thereby increasing the amount of levees that can be repaired with available funds.

Though much smaller than the proposed study, ERS is currently implementing similar studies characterizing potential water resource impacts from dredge sediments on two Delta islands. These studies are entering their second year and clearly show that dredge sediments do not pose a significant threat, and in many cases improve water quality. The proposed study expands our current study across the Delta, thereby leveraging and building upon the work, science, and insight already gathered by ERS.

The data generated by the proposed study will significantly inform decisions regarding the management and allowable uses of dredge sediments. Assuming that the study concludes that dredge sediments do not pose a significant threat to water resources, the public and all parties directly involved in Delta levee repair (e.g. DWR, reclamation districts), in water resource management (e.g., DWR, Regional Board) will benefit.

Based on levee construction projects using many thousands of cubic yards of material, the economic and environmental cost-benefits to all parties from this study are likely to be significantly large. The findings are expected to allow the federal and state dollars allocated to levee construction to be far more effective in protecting the public, property, and the California water supply. Additionally, environmental and infrastructure impacts associated with importing fill materials could be avoided. Other benefits to the public are likely to flow from the data characterizing the actual ambient chemistry of water resources in the Delta.

2. REQUIRED INFORMATION

2.1 NAME AND PURPOSE OF POTENTIAL INITIAL PROJECT

The name of the proposed project is:

- *Characterization of Threats to Water Resources from Dredge Sediments Used on Levees in the Sacramento – San Joaquin Delta Islands, California.*

The purpose of the proposed project is to:

- Characterize the potential environmental and economic impacts, both beneficial and detrimental, to water resources posed by dredge sediments used on levees throughout the Delta.

2.2 LOCATION

There are approximately 1,100 miles of levee throughout the Delta. The proposed project currently anticipates studying locations along the levees that adequately represent the full range of variability in soil, geology, surface water quality, ground water quality, dredge sediment quality, levee age, and land use. The study will be implemented throughout the Sacramento – San Joaquin Delta because:

- Dredge sediments have been historically used throughout the Delta to construct and maintain levees,
- Levees throughout the Delta currently require, and will continue to require maintenance and repair,
- Dredge sediments are available throughout the Delta.

The study also anticipates characterizing fill materials beyond the boundaries of the Delta. Taken together, data describing the dredge sediments and alternative fill materials should then allow a direct comparison of the:

- Threat posed to water resources by each type of material,
- Economic cost-benefit of importing fill material versus utilizing local sediments,
- Environmental cost-benefit of importing fill materials versus utilizing local sediments.

2.3 PROBLEM

This study specifically addresses the problem of identifying the lowest cost source of fill materials to be used in levee repair and maintenance. Currently, dredge sediments are the lowest cost source of fill materials to most locations in the Delta. However, the Regional Board prohibits the use of dredge sediments on levees. The specific problem addressed by the proposed study is the lack of data characterizing the quality of, and the potential threat to water resources posed by, dredge sediments. This study is expected to generate data that should allow the Regional Board to reconsider the current prohibitions.

The current Regional Board prohibitions make responding to emergencies, such as levee break, all the more difficult because local sources of fill materials can not be used. Further, as experienced by DWR at Jones Tract, the Regional Board concerns required approximately $500,000 to be spent in response to unfounded concerns regarding the use of approximately $15,000 worth of dredge sediments. While there is significant value in the dredge materials

used to repair the levee, no measurable value was derived from the remedial response that was required following the placement of the dredge sediments in the levee.

Finally, the Regional Board is concerned about the pH of sediments, which is incorrectly used as a surrogate indicator of a threat to water quality. In response to sediment with a pH less than 6, the Regional Board has required lime to be added to dredge sediments to raise the pH to neutral (pH of 7). However, the data clearly show that adjusting sediment pH is the single-most significant cause of adverse impacts to water quality, where none existed before. Under separate cover, ERS is proposing a study to specifically address the Regional Board's pH concerns and requirements to adjust pH.

2.4 OPPORTUNITIES

The results from this study can be used to identify the lowest cost source of fill materials that could be used to reduce flood risk, respond to emergencies, repair and maintain levees, and protect water resources. Based on the focused dredge sediment studies performed to date, dredge sediment does not pose a significant threat to water resources. If this proposed study demonstrates that dredge sediments available throughout the Delta do not pose a significant threat to water resources, then this study provides the opportunity to maximize the cost-effectiveness of dollars spent on fill materials used in levee projects. Further, this study should significantly reduce uncertainty regarding the relationships between dredge sediment quality, geologic materials, ground water quality, and surface water quality in the Delta.

2.5 PROJECT DESCRIPTION

The proposed study is focused on characterizing potential environmental and economic impacts, both beneficial and detrimental, to water resources posed by dredge sediments used on levees throughout the Delta. The proposed characterization effort consists of the following four elements:

- Characterize the quality of sediments currently in the levee system:
- Characterize the ground water quality downgradient from the levees,
- Characterize the quality of river sediments and surface water,
- Characterize the quality of alternative fill materials that could be imported to the Delta.

Characterizing environmental impacts would involve direct evaluations of chemical concentrations with relevant standards and goals. In addition, the evaluation of environmental impacts could involve developing a relevant non-monetary metric to compare the impacts

associated with dredge sediments with those associated with the use of alternative fill materials. Economic impacts in monetary terms of dredge sediments and alternative fill materials could be similarly evaluated.

2.5.1 Characterize The Quality Of Sediments Currently In The Levee System:

This study element will characterize the quality of sediments in the levee system. The characterization of the geochemical changes of sediments and threats to water resources will directly involve the collection and analysis of water and sediment samples. Drilling equipment will be used to collect sediment samples from the levees and underlying native geologic materials. The samples will be collected from the top, middle, and bottom of the levee, and from the underlying native peat, clay, and sand materials.

These solid samples will be analyzed for a variety of inorganic constituents, including metals, general minerals, and physiochemical parameters. The total concentration and, as appropriate, the water-soluble concentration of each constituent will be measured. Samples of surface water and ground water will also be sampled and analyzed for soluble concentrations of the same constituents. The analytical data will be used to evaluate if sediments comprising the levee have impacted water quality.

2.5.1.1 Brief Discussion of Expected Changes in Sediment Geochemistry

Prior to dredging, sediments are water saturated and reside in a nearly anoxic (very low oxygen) riverbed. Upon dredging, the sediments are placed in an upland environment that is eventually drained of water, leaving the dredge sediments unsaturated and in a relatively oxic (oxidizing) condition. Because all materials seek equilibrium with the environment, the geochemistry of the sediment in the reducing riverbed environment will undergo dramatic geochemical changes following dredging to equilibrate with the oxidizing upland environment.

2.5.1.2 Brief Discussion of Analytical Methods

There are several types of analytical methods designed to measure the soluble fraction of chemicals present in a solid. It is this soluble fraction that has the potential to impact water quality. These methods include variations of the California Waste Extraction Test, EPA methods, and methods developed by ASTM.

2.5.2 *Characterize The Ground Water Quality Downgradient From The Levees:*

This study element will characterize the quality of ground water downgradient from the levees. Monitor wells will be installed along a transect extending from the levee sampling location in the above element (Figure 1). Ground water samples will be collected four times per year and analyzed for the same set of soluble chemicals listed in the preceding study element.

These data will provide a basis for assessing the significance of any threat to ground water resources potentially posed by dredge sediments, or other materials used on the levees. Additionally, these data will describe the quality of ground water downgradient from the levees, changes in ground water quality over time, and the relevant effects of different land uses, geologic materials, and seasons on ground water quality. Overall, the data should reasonably characterize background, or ambient, ground water quality throughout the Delta.

2.5.3 *Characterize The Quality Of Riverbed Sediments:*

The above elements characterize the current impacts to and threats posed to water resources by sediments already used in levees. This study element will characterize the quality of riverbed sediments yet to be dredged and possibly used in the future to repair levees. These data will provide a better understanding of the distribution and variation in sediment chemistry in the Delta. These data will also be used to compare, and possibly correlate, the current riverbed sediment geochemistry with the current levee sediment geochemistry. The sediment samples will be analyzed for a variety of total and water soluble constituents, and physiochemical parameters.

2.5.4 *Characterize The Quality Of Fill Materials Imported To The Delta:*

This study element will characterize the quality of likely alternative sources of fill materials that would be imported to the Delta. Representative samples will be collected from each source and analyzed as described above. This information will provide an environmental and economic basis for comparing potential threats posed by the reuse of dredge sediments with other relevant sources of fill materials.

2.6 STATEMENT OF WILLINGNESS AND ABILITY TO COST SHARE

ERS has discussed a brief outline of this proposed study with Les Harder and Steve Verigin of the California Department of Water Resources, and with Ms. Lynn O'Leary with the Corps. Both parties indicated general support for the study. Upon further consideration, DWR

recently added that they "support the consideration of the study" and is "willing to cost share a portion of the study."

2.7 POINT OF CONTACT & AGENCY AFFILIATION

The point of contact for the proposed study is:

Steven Michelson, PG
Principal Geologist
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2121 N. California Blvd., Suite 820,
Walnut Creek, CA 94596
Office = 925.938.1600 x102
Cell = 510.407.2864

2.8 COST AND SCHEDULE

The cost associated with this study is scalable, up or down, depending the number of locations investigated, samples collected, and analyses performed. The schedule associated with this study is similarly scalable depending on the frequency and duration of the monitoring period. We estimate that a comprehensive Delta-wide investigation incorporating studies of levee materials, surface water quality, riverbed sediment, alternative fill materials, and 2 years of ground water quarterly monitoring would require approximately 3 to 3.5 years and approximately $ 3.8 to $ 4.3 million. A reduced study of levee materials, surface water quality, riverbed sediment, alternative fill materials, and 1 year of ground water quarterly monitoring would require approximately 2 to 2.5 years and approximately $ 2.3 to $ 2.8 million.

3. SCOPING AND SCREENING INFORMATION

3.1 ITEM 1: URGENCY

There is an urgent need to repair and maintain levees throughout the Delta. Aside from labor, fill materials easily comprise the single largest cost to levee construction and, in many cases, dredged sediments are the least expensive source of fill materials. However, pending data characterizing the actual posed by dredge sediments, the Regional Board prohibits the use of dredge sediments on levees. Additionally, the Regional Board is nearly to the point of

prohibiting the placement of dredge sediments on the ground. In some cases, this prohibition has effectively stopped dredging.

Therefore, generating information about the actual impacts from dredge sediments is expected to allow the Regional Board to relax the prohibitions. Given the current public awareness of the need to repair levees, the permitted use of dredge sediments on levees will increase the cost-effectiveness of levee repair, thereby increasing the amount of levees that can be repaired with available funds.

In addition to levee repair, dredging sediments from the river is another important factor to reducing flood risk. While levee repair strengthens and raises the height of the levee, dredging sediments increases the flood capacity of the river, which reduces the hydraulic and erosion pressures on the levee. Therefore, there is an urgent need to generate information that can better inform future decisions regarding dredging and the placement of dredged sediments on the ground.

3.2 ITEM 2: CHANGE IN FLOOD FLOWS

Because dredge sediments, in most cases, are the most cost effective source of fill materials, using dredge sediments on levees would allow more levees to be repaired and strengthened against flood flows. Therefore, this study has a direct impact on the ability of state and federal agencies to cost-effectively and maximize levee repair.

3.3 ITEM 3: FLOODING, ECOSYSTEM, WATER SUPPLY QUALITY

This study will provide information regarding the quality and suitability of sediments and regionally available fill materials for use in flood control, ecosystem enhancement, and water quality improvement projects.

3.4 ITEM 4: NON-STRUCTURAL APPROACHES

This study is focused on the quality fill materials to be used in levee repair. Although the entire study is non-structural, it will significantly benefit structural projects, such as levee repair and emergency response.

3.5 ITEM 5: BENEFACTORS

The likely benefactors are all agencies involved with levee repair and water resource management. The public is also a large benefactor because the study is expected to make levee repair budgets much more cost effective.

3.6 ITEM 6: LIKELY SUPPORT

DWR has indicated support for the project. Although other non-federal agencies have not yet been contacted, we suspect strong support from most, if not all, agencies involved with the Delta, including the Regional Board.

3.7 ITEM 7: KNOWN CHALLENGES AND OBSTACLES

There are no known obstacles that would prevent the implementation of this study.

3.8 ITEM 8: NON-FEDERAL SPONSOR SUPPORT

DWR has expressed a willingness to support and cost-share the proposed study. Other possible sponsor's include reclamation districts and CalFed.

4. BRIEF DESCRIPTION OF ERS

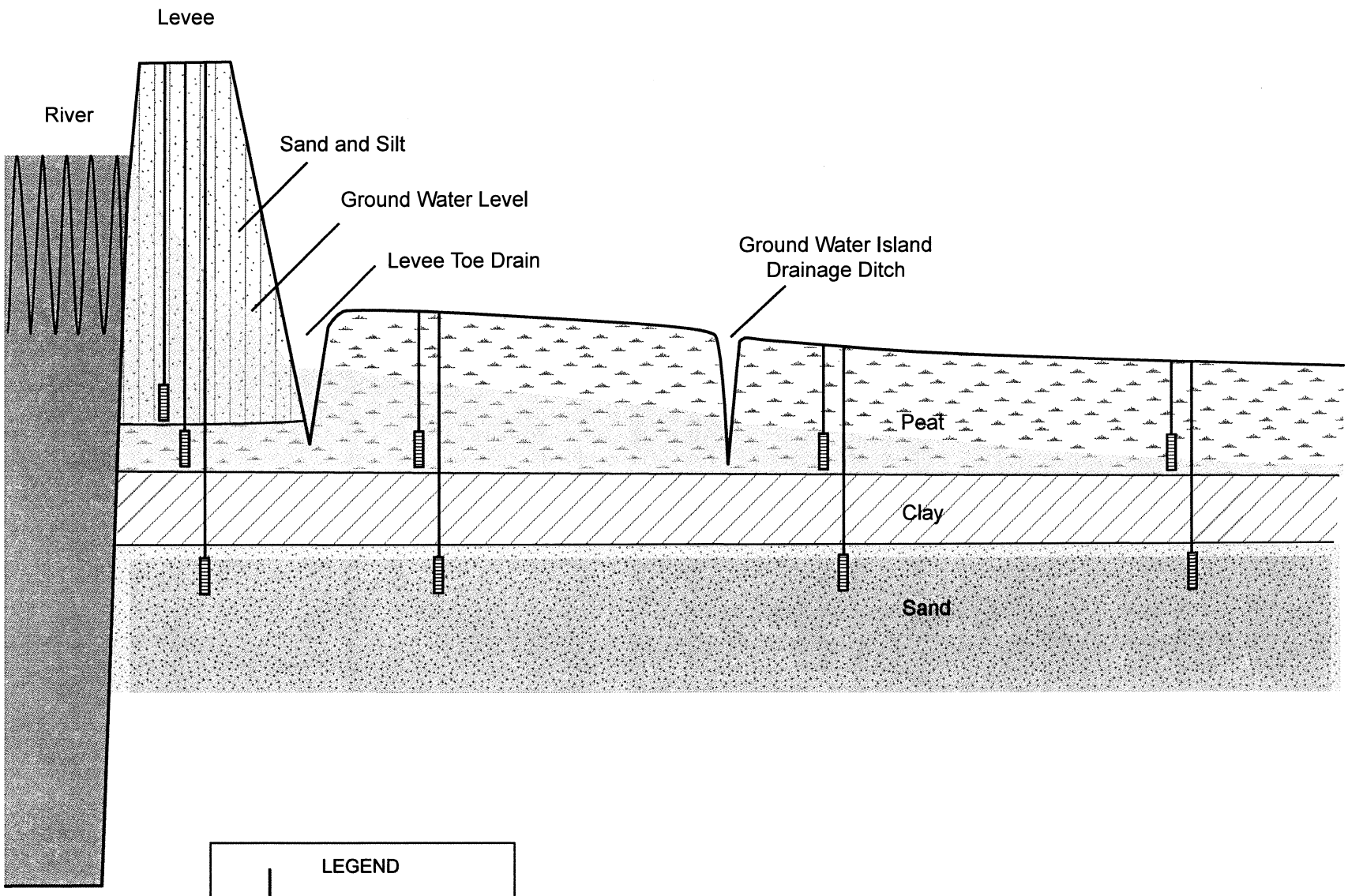
ERS is an environmental consulting firm currently studying the potential impacts to water resources posed by dredge sediments on Roberts Island and Rough and Ready Island. Though still underway, these studies strongly suggest that dredge sediments do not pose a threat and may actually benefit the quality of water resources. These studies also revealed significant adverse impacts to ground water quality resulting from the application of agricultural lime, which is a common practice throughout the Delta. These studies and projects included preparing dredging permits and environmental investigations that characterize:

- Chemical and toxicological threats posed by dredging activities,
- Chemical impacts and toxicological threats attributable to sediments placed on levees,
- Chemical impacts and toxicological threats attributable to adjusting the pH of sediments with lime,

- Geochemical changes in sediments that are dredged from the riverbed, delivered to dredge sediment placement sites, and subsequent reused on levees,
- Ground water chemistry changes beneath dredge sediment placement sites,
- Surface water chemistry changes adjacent to dredge sediment placement sites,
- Background ground water quality within several Delta islands,
- Various reuses of dredge sediments,
- Chemical contamination sites and design of appropriate remedial measures.

The results of these investigations have provided us with significant insight into the geochemical nature of dredge sediments, ground water, and surface water in the Delta. Our studies have withstood significant scrutiny from the Regional Water Quality Control Board and various non-governmental environmental organizations, such as DeltaKeeper.

As a direct result of these investigations, ERS is uniquely qualified to perform the proposed study. Our staff and project experience in the Delta provides us with unparalleled insight into the geochemistry of Delta riverbed sediments, agricultural peat soils, and quality of ground water and surface water. In addition to our consulting experience, our staff includes scientists who have performed doctoral and post-doctoral research at UC Berkeley, UC Davis, and UC Santa Cruz. Their work has been published in such prestigious peer-reviewed journals as Nature, Biogeochemistry, Plant and Soil, Soil Science Society of America Journal, Communications in Soil Science and Plant Analysis. Much of the previous academic research performed by our staff is directly relevant to delta sediment chemistry issues, such as agricultural practices, peat soils, the influence of pH on mineral and organic acids, metals attenuation, nitrogen cycling, and the mechanisms affecting various analytical methods used to predict solubility. Furthermore, our staff has maintained collaborative relationships with the academic science community who can provide additionally assistance when needed.



Typical Delta Island Cross Section
Stockton, California

Figure
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PROPOSAL:

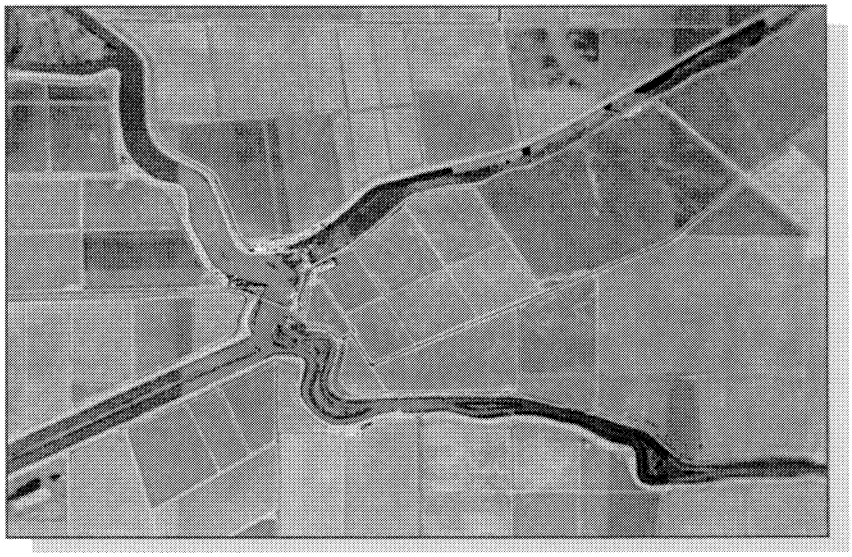
CHARACTERIZING THREATS TO WATER RESOURCES PROTECTED BY THE LEVEE SYSTEM FROM LIME APPLICATION ON CULTIVATED PEAT SOILS

in the

SACRAMENTO – SAN JOAQUIN DELTA ISLANDS, CALIFORNIA

RESPONSE to January 4, 2006 RFP by:

CALFED LEVEE SYSTEM INTEGRITY PROGRAM
UNITED STATES ARMY CORPS OF ENGINEERS
CALIFORNIA DEPARTMENT OF WATER RESOURCES



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CHARACTERIZING THREATS TO WATER RESOURCES PROTECTED BY THE LEVEE SYSTEM FROM LIME APPLICATION ON CULTIVATED PEAT SOILS

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SECTION PAGE

1. INTRODUCTION AND EXECUTIVE SUMMARY

Environmental Risk Services Corporation (ERS) has prepared this *Proposal: Characterizing Threats to Water Resources Protected by the Levee System from Lime Application on Cultivated Peat Soils in the Sacramento – San Joaquin Delta Islands, California* (Proposal) pursuant to the CALFED request for proposal (RFP) dated January 4, 2006. The levee system in the Delta provides many benefits, include support of flood control efforts and water quality management.

This proposed study is focused on characterizing the impacts to water resources caused by a common management practice employed on cultivated peat soils throughout the Delta. Agricultural practices throughout the Delta, and in many parts of the Central Valley, apply lime to raise the pH of soil. In many other parts of the world, the practice of raising pH of delta peat soils through lime application has been shown to significantly increase leaching of salts (as ammonium, bicarbonate, sulfate, and nitrate) and metals such as copper, mercury, arsenic, selenium, and molybdenum. For example, elevated arsenic concentrations in shallow ground water are associated with limed delta peat soils in Bangladesh and Vietnam.

Existing data show elevated salt and dissolved metals in ground water in many areas of the Delta. Because ground water is drained from the Delta islands and returned to surface water, the widespread application of lime to peat soils poses a potential threat to both ground water and surface water quality. Better understanding of how this land management practice impacts water quality in the California Delta may (1) identify a significant source of water quality impacts, (2) identify approaches to minimizing these impacts, and (3) significantly improve the value of the levee system by improving water resource quality.

However, the California Regional Water Quality Control Board (Regional Board) appears to be unaware of the influence lime application has on the release of salts and metals into water supplies. The Regional Board has incorrectly assumed that dredge sediments used in levee construction, rather than the adjacent cultivated peat soils, are the primary source of impacts to water resources. As a direct consequence of this knowledge gap, the Regional Board does not currently allow dredge sediments to be used for levee repair. This fundamental misunderstanding of environmental chemistry also resulted in the Regional Board requiring DWR to raise the pH of the dredge sediments used in the Trapper Slough levee repair.

This proposed study is relevant to the RFP because it will likely (1) identify a significant source of water quality and ecosystem impacts, (2) lead to changes in land use management that reduce impacts to water resources, (3) identify the limed peat soils as a source of quality impacts, which correspondingly relieves suspicion of the levee construction materials, and (4) add value to the levee system by improving the quality of water resources in the Delta.

2. REQUIRED INFORMATION

2.1 NAME AND PURPOSE OF POTENTIAL INITIAL PROJECT

The name of the proposed project is:

- *Characterizing threats to water resources protected by the levee system From lime application on cultivated peat soils*

The purpose of the proposed project is to:

- Characterize the impact of agricultural lime application on cultivated peat soils to water and ecological resources.
- Identify best management practices that could be used to mitigate any adverse impacts on water and ecosystem quality that may be revealed by the proposed study.

2.2 LOCATION

The study will be implemented primarily on a Delta island where liming has occurred and on a separate island, or localized area, where liming of peat soils has not occurred.

Over half of the approximately 630,000 acres that once comprised the Sacramento – San Joaquin Delta estuary are now drained and cultivated for agriculture. These approximately 373,000 acres of agricultural land in the Sacramento - San Joaquin Delta are classified as "lowlands" (below the 5 foot mean sea level contour). These "lowland" soils were year-round wetlands before the levee system was established. After more than a century of drainage, cultivation, and consequent loss of soil organic matter, the present day land surface is now several feet below sea level on many of these delta islands. When these wetlands are drained for agriculture, oxidation reactions generate acidic soil conditions. Management of these soils often employs the application of agricultural lime to maintain near-neutral pH. Management also includes the continuous pumping out of subsurface drainage water to maintain aerated conditions in the (below sea level) topsoil. Drainage water from these lowland cultivated peat soils is discharged directly into the river, along with any metals and salts that may have been added to it during its percolation through the impacted soils.

2.3 PROBLEMS

This proposed study would directly investigate a likely significant detrimental impact to ecosystem health and water quality. Specifically, this study will elucidate the impact of agricultural lime application to delta peat may have on water quality. Based on results of preliminary investigations in the Delta and more extensive studies throughout the world, this study will examine release of salts (ammonium, bicarbonate, sulfate, and nitrate) and metals (copper, mercury, arsenic, selenium, and molybdenum) when lime is applied to delta peat soils. Knowledge generated by this study could lead directly to the development of improved soil management strategies to protect water and ecosytem quality.

2.4 OPPORTUNITIES

Preliminary investigations by ERS have revealed that there is an opportunity to characterize a potentially significant source of metals and salts impacting water quality in the delta. By elucidating agricultural lime application as a major variable influencing release of metals and salts. Assuming the results of the proposed study are similar to those performed at similar locations elsewhere in the world, this study will provide the opportunity to identify mechanisms that significantly reduce detrimental impacts to water quality and ecosystem resources. For example, elevated arsenic concentrations in shallow ground water are associated with limed delta peat soils in Bangladesh and Vietnam.

In some cases, agricultural lime causes arsenic, copper, molybdenum, mercury, selenium, and ammonia to be mobilized in soil and released, along with nitrate, into ground water. Understanding the biogeochemical processes that regulate release of metals and salts into waters of the Sacramento – San Joaquin Delta is complicated by the fact that none of the interactions occur in isolation. Every chemical reaction produces a product that can be used as a reactant for a different reaction, and most of these processes are intimately interrelated. This is further complicated by the biological component – the role played by the many different species of microorganisms that carry out the vast majority of chemical transformations influencing water quality. As surface soils go through an annual wetting and drying cycle, chemical parameters in water can vary over a tremendous range throughout the year. These seasonal changes and land use practices significantly affect nitrogen and carbon cycling, which in turn can significantly affect water quality.

2.5 PROJECT DESCRIPTION

The proposed study is focused on characterizing the potential water resource impacts due to lime added to cultivated peat soils. The proposed characterization effort consists of the testing the following hypotheses.

Hypothesis 1: In the absence of agricultural lime application, where soil pH is between 4.0 and 5.0 (typical for natural peat soils), there are very low concentrations of soluble organic nitrogen, ammonia, nitrate, arsenic, copper, molybdenum, mercury, and selenium, which could be mobilized into ground water or surface water.

Hypothesis 2: When agricultural lime is applied to raise the soil pH to >6.0, soluble concentrations of the above chemicals would increase, posing a threat to water quality.

Hypothesis 3: When agricultural lime is applied with consequent release of nitrate, some of this nitrate will enter groundwater where it acts as an oxidant for compounds such as pyrite, iron, manganese, and arsenic. This in turn can adversely impact ground water quality.

Testing these hypotheses will require the following:

- Identify a limed cultivated peat soil and unlimed native peat soil for evaluation
- Peat samples from various depths will be collected and analyzed during the wet and dry season, and prior to and following intense irrigation events.
- In a controlled laboratory environment, native peat soil will be subjected to lime application at rates equivalent to typical agricultural practices. Leachate from the limed peat soil will be (1) analyzed, and (2) used as input solution to unlimed peat subsoil to simulate field wetting events, assess attenuation and threat to ground water.
- Ground water quality underlying both types of peat will be monitored quarterly.
- Surface water quality in adjacent drainage ditches will be monitored quarterly.

2.6 STATEMENT OF WILLINGNESS AND ABILITY TO COST SHARE

ERS has discussed a brief outline of this proposed study with Les Harder and Steve Verigin of the California Department of Water Resources, and with Ms. Lynn O'Leary with the Corps. Both parties indicated general support for the study. Upon further consideration, DWR recently added that they "support the consideration of the study" and is "willing to cost share a portion of the study."

2.7 POINT OF CONTACT & AGENCY AFFILIATION

The point of contact for the proposed study is:

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2.8 COST AND SCHEDULE

The cost associated with this study is scalable, up or down, depending the number of locations investigated, samples collected, and analyses performed. The schedule associated with this study is similarly scalable depending on the frequency and duration of the monitoring period. We estimate that a comprehensive investigation including 2 years of quarterly ground water and surface water monitoring would require approximately $500,000 to $800,000 and about 3 years to complete.

3. SCOPING AND SCREENING INFORMATION

3.1 ITEM 1: URGENCY

Existing data clearly show elevated concentrations of metals and salts in ground water and surface throughout the Delta. Existing data also show similar conditions in delta peat environments elsewhere in the world. Scientific literature is beginning to demonstrate a significant linkage between lime application to cultivated soils and the generation of soluble metals and salts. The recent crash of Delta Smelt population has added further urgency to correctly identify the source(s) of these impacts to water resource quality. Equally, misidentification of a source (e.g., dredge sediments) would significantly impact the availability of inexpensive levee fill materials.

3.2 ITEM 2: CHANGE IN FLOOD FLOWS

Not applicable.

3.3 ITEM 3: FLOODING, ECOSYSTEM, WATER SUPPLY QUALITY

This study will provide information describing the role of lime application on peat soils and their resultant contribution of soluble metals and salts to water resources. This in turn will enable land managers to develop improved techniques to mitigate adverse impacts to water quality attributable to lime application.

3.4 ITEM 4: NON-STRUCTURAL APPROACHES

This study should provide a logical basis for mitigation of adverse impacts to water quality from lime application without requiring any structural improvements to the Delta.

3.5 ITEM 5: BENEFACTORS

The likely benefactors are all agencies involved with levee repair and water and ecological resource management. The public is also a large benefactor because the study is expected to provide information that will improve water quality and ecosystem health.

3.6 ITEM 6: LIKELY SUPPORT

DWR has indicated support for the project. Although other non-federal agencies have not yet been contacted, we suspect strong support from most, if not all, agencies involved with the Delta, including the Regional Board.

3.7 ITEM 7: KNOWN CHALLENGES AND OBSTACLES

There are no known obstacles that would prevent the implementation of this study.

3.8 ITEM 8: NON-FEDERAL SPONSOR SUPPORT

DWR has expressed a willingness to support and cost-share the proposed study. Other possible sponsor's include reclamation districts and CalFed.

4. BRIEF DESCRIPTION OF ERS

ERS is an environmental consulting firm currently studying the potential impacts to water resources posed by dredge sediments on Roberts Island and Rough and Ready Island. Though still underway, these studies strongly suggest that dredge sediments do not pose a threat and may actually benefit the quality of water resources. These studies also revealed significant adverse impacts to ground water quality resulting from the application of agricultural lime, which is a common practice throughout the Delta. These studies and projects included preparing dredging permits and environmental investigations that characterize:

- Chemical and toxicological threats posed by dredging activities,
- Chemical impacts and toxicological threats attributable to sediments placed on levees,
- Chemical impacts and toxicological threats attributable to adjusting the pH of sediments with lime,
- Geochemical changes in sediments that are dredged from the riverbed, delivered to dredge sediment placement sites, and subsequent reused on levees,
- Ground water chemistry changes beneath dredge sediment placement sites,
- Surface water chemistry changes adjacent to dredge sediment placement sites,
- Background ground water quality within several Delta islands,
- Various reuses of dredge sediments,
- Chemical contamination sites and design of appropriate remedial measures.

The results of these investigations have provided us with significant insight into the geochemical nature of dredge sediments, ground water, and surface water in the Delta. Our studies have withstood significant scrutiny from the Regional Water Quality Control Board and various non-governmental environmental organizations, such as DeltaKeeper.

As a direct result of these investigations, ERS is uniquely qualified to perform the proposed study. Our staff and project experience in the Delta provides us with unparalleled insight into the geochemistry of Delta riverbed sediments, agricultural peat soils, and quality of ground water and surface water. In addition to our consulting experience, our staff includes scientists who have performed doctoral and post-doctoral research at UC Berkeley, UC Davis, and UC Santa Cruz. Their work has been published in such prestigious peer-reviewed journals as Nature, Biogeochemistry, Plant and Soil, Soil Science Society of America Journal, Communications in Soil Science and Plant Analysis. Much of the previous academic research performed by our staff is directly relevant to delta sediment chemistry issues, such as agricultural practices, peat soils, the influence of pH on mineral and organic acids, metals attenuation, nitrogen cycling, and the mechanisms affecting various analytical methods used to predict solubility. Furthermore, our staff has maintained collaborative relationships with the academic science community who can provide additionally assistance when needed.